

REMARKS

Claims 1, 4, 6, 21, 25, and 30-32 have been amended and claims 33 and 34 added herein. Upon entry of this amendment, claims 1, 4, 6, 20-25, and 30-34 will be pending in the above-identified application.

Section 112 - Claims 4 and 21

Applicants respectfully request reconsideration of the rejection of Claims 4 and 21 under 35 U.S.C. § 112, second paragraph, as being indefinite.

Claim 4 has been amended by replacing "intersects" with "meets" to clarify the interfaces being referred to.

Claim 21 has been amended to clarify identification of the impurity concentration within the epitaxial layer and identification of the surface of the emitter of the second vertical type bipolar transistor. The "concentration at all depths of the second vertical type bipolar transistor" language of claim 21 does *not* include all depths of the second embedded diffusion layer, as is clear from the claim language: "*at all depths of the second vertical type bipolar transistor between the surface of the emitter of the second vertical type bipolar transistor and a position of peak impurity concentration within the second embedded diffusion layer.*" (emphasis added).

Because claims 4 and 21 particularly point out and distinctly claim the invention, the rejection is Improper and Applicants respectfully request the rejection be withdrawn.

Section 102 - Claim 32

Applicants respectfully request reconsideration of the rejection of Claim 32 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,357,622 (Magdo). Claim 32 recites a semiconductor device having a first and a second vertical type bipolar transistor, each having an emitter, a base, and a collector, a first and a second embedded diffusion layer, wherein the second embedded diffusion layer includes an impurity concentration that is less than an impurity concentration of the first embedded diffusion layer and **the collector of the first vertical type bipolar transistor has a thickness that is less than a thickness of the collector of the second vertical type bipolar transistor**, which results in the second vertical type bipolar transistor having a

breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

Magdo discloses a transistor structure having a bipolar NPN and a bipolar PNP transistor. Magdo does not show the second embedded diffusion layer includes an impurity concentration that is less than an impurity concentration of the first embedded diffusion layer and the collector of the first vertical type bipolar transistor has a thickness that is less than a thickness of the collector of the second vertical type bipolar transistor such that the second vertical type bipolar transistor has a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

Although Applicants believe Magdo does not expressly or inherently show a second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor and Applicants do not believe that the present recitation of these features is functional or represents an intended use, claim 32 has been amended to include physical characteristics which, together with already recited limitations, result in the second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor. See e.g., Specification, page 22, lines 3-11. Magdo does not show the claimed physical characteristics, including the collector of the first vertical type bipolar transistor having a thickness that is less than a thickness of the collector of the second vertical type bipolar transistor, which result in the second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

Because the reference does not show every element of the claim, the rejection is improper. Accordingly, Applicants respectfully request the rejection be withdrawn.

Section 103 - Claims 1, 4, 6, 21-23, 25, 30, and 31

Applicant respectfully requests reconsideration of the rejection of claims 1, 4, 6, 21-23, 25, 30, and 31 under 35 U.S.C. § 103(a) as being unpatentable over Magdo in view of U.S. Patent No. 5,151,765 (Yamauchi).

Each of claims 1, 4, 6, 21-23, 25, 30, and 31 recites a semiconductor device having a first vertical type bipolar transistor and a second vertical type bipolar transistor, each having an emitter, a base, and a collector, the semiconductor device, wherein the

collector of the first vertical type bipolar transistor has a thickness that is less than a thickness of the collector of the second vertical type bipolar transistor, which results in the second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

Magdo discloses a transistor structure having a bipolar NPN and a bipolar PNP transistor. Yamauchi discloses a semiconductor device having a first and second bipolar transistors. Magdo and Yamauchi, individually and in combination, fail to show or suggest the collector of the first vertical type bipolar transistor having a thickness that is less than a thickness of the collector of the second vertical type bipolar transistor, which results in the second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

As amended, claim 4 further recites a distance between a location of peak impurity concentration within the second embedded diffusion layer and a location where the second embedded diffusion layer meets the substrate is less than one-half of a distance between the location of peak impurity concentration and a location where the second embedded diffusion layer meets the epitaxial layer. The matter recited in claim 4 is not shown, inherent, or suggested in the prior art. The Office action rejects claim 4 based on the idea that it is well known that diffused areas have concentrations that follow a natural distribution curve, citing Fig. 9, item 22", of Watanabe et al. as an example. See page 6, line 17, to page 7, line 4. Applicants are proceeding under the assumption that Examiner is referring to U.S. Patent No. 4,258,379 here and, if Applicants' assumption is incorrect, requests a new Office action correctly identifying the reference relied on. The Office action improperly substitutes wording ("diffused areas have concentration that follows natural distribution curve") for the wording of the claim and attempts to reject the claim based on the substituted wording. Although it may be known for diffused areas to have concentrations that follow a natural distribution curve, following a natural distribution curve is not the substance of the claim. The Examiner appears to represent that because natural distribution curves of impurity concentrations in semiconductor layers are common, it would have been obvious to dope one of the layers such that a distance between a location of peak impurity concentration within the second embedded diffusion layer and a location where the second embedded diffusion layer meets the substrate is less than one-half of a distance

between the location of peak impurity concentration and a location where the second embedded diffusion layer meets the epitaxial layer. Such rationale is unclear and unfounded. If the Examiner wishes to maintain the rejection, Applicants request the Examiner do so in a new non-final Office action clearly showing how the claimed substance is shown, suggested, or inherent in the prior art.

As amended, claim 6 further recites that an impurity concentration of the second embedded diffusion layer is between about 1×10^{13} and about 1×10^{15} . Magdo does not show or suggest a second embedded diffusion layer having an impurity concentration between about 1×10^{13} and about 1×10^{15} . The Office action cites column 4, lines 8-9 of Magdo as disclosing a second embedded diffusion layer having an impurity concentration of 1×10^{13} to 1×10^{15} . However, the recitation in these lines refer to a preferred level of *energy use* from about 1×10^{14} ions/cm² to about 1×10^{15} ions/cm² and not levels of *impurity concentration* (measured in atoms/cm³).

As amended, claim 21 further recites an impurity concentration of the second embedded diffusion layer that is approximately equal to or higher than the epitaxial impurity concentration at all depths of the second vertical type bipolar transistor between the surface of the emitter and a position of peak impurity concentration within the second embedded diffusion layer. As with claim 4, the Office action rejects claim 21 based on the idea that it is well known that diffused areas have concentrations that follow a natural distribution curve, citing Fig. 9, item 22", of Watanabe et. al as an example. See page 6, line 17, to page 7, line 4. Again, the Office action improperly substitutes wording ("diffused areas have concentration that follows natural distribution curve") for the wording of the claim and attempts to reject the claim based on the substituted wording. Although it may be known for diffused areas to have concentrations that follow a natural distribution curve, following a natural distribution curve is not the substance of the claim. The Examiner appears to suggest that because natural distribution curves of impurity concentrations in semiconductor layers are common, it would have been obvious to have an impurity concentration of the second embedded diffusion layer that is approximately equal to or higher than the epitaxial impurity concentration at all depths of the second vertical type bipolar transistor between the surface of the emitter and a position of peak impurity concentration within the second embedded diffusion layer. This rationale is incorrect. If the Examiner

wishes to maintain the rejection, Applicants request the Examiner do so in a new non-final Office action clearly showing how the claimed substance is shown in or suggested by the prior art.

Further regarding claim 21, the matter recited particularly in the claim is not shown in or suggested by the prior art and the device of the cited reference has qualities other than those claimed. Namely, the cited Watanabe reference shows impurity concentrations 22" of the diffused layer 22 that are lower than impurity concentrations of the epitaxial layer at a depth between the surface of the emitter and a position of peak impurity concentration within the diffused layer. See, e.g., Watanabe, Fig. 9. Thus, Watanabe does not illustrate the claimed elements.

As amended, claim 22 further recites a peak position of an impurity concentration of the second embedded diffusion layer residing at a distance from the surface of the emitter of the second vertical type bipolar transistor that is approximately equal to a distance from the bottom of the first embedded diffusion layer to the surface of the emitter of the first vertical type bipolar transmitter. Magdo fails to disclose or suggest the claimed elements. Figs. 8 and 9 of Magdo show an impurity concentration profile for the PNP and NPN transistors, respectively, that plots impurity concentration levels (Y-axis) against depth (X-axis) from the top of the transistor structure. It is clear from these figures, having the same X-axis scale, that the locations of peak impurity concentration for the respective transistors are substantially the same. Magdo fails to show or suggest a peak position of an impurity concentration of the second embedded diffusion layer residing at a distance from the surface of the emitter of the second vertical type bipolar transistor that is approximately equal to a distance from the bottom of the first embedded diffusion layer to the surface of the emitter of the first vertical type bipolar transmitter, as claimed.

Claim 23 further recites that the first embedded diffusion layer includes an impurity concentration that is higher than the epitaxial impurity concentration. Magdo fails to disclose the claimed elements.

As amended, claim 25 recites the second embedded diffusion layer is an N⁺-type second embedded diffusion layer and is slightly diffused into a lower part of the epitaxial layer. Magdo and Yamauchi, individually and in combination, fail to disclose or suggest this matter. Note, for instance, that barrier region 18, identified on page 3 of the Office

action as the second embedded diffusion layer in Magdo, is of the N⁺, and not an N⁺ type, as claimed. The Office action fails to address claim 25.

As amended, claim 30 recites the thickness of the collector of the first vertical type bipolar transistor being less than the thickness of the collector of the second vertical type bipolar transistor also results in the first vertical type bipolar transistor operating at a higher speed than the second vertical type bipolar transistor. The references, individually and in combination, do not show or suggest the elements of claim 30. The rejection of claim 32 includes rationale for why the claimed high speed characteristic is inherently shown in Magdo, including that Magdo discloses a structure identical to that claimed. This rationale is in error for many reasons. As one reason, the structure of the claims and of Magdo are different. Specifically, Magdo does not disclose the thickness of the collector of the first vertical type bipolar transistor being less than the thickness of the collector of the second vertical type bipolar transistor.

As amended, claim 31 recites the thickness of the collector of the first vertical type bipolar transistor being less than the thickness of the collector of the second vertical type bipolar transistor results in the second vertical type bipolar transistor operating at a higher voltage than the first vertical type bipolar transistor. The references, individually and in combination, do not show or suggest the elements of claim 31.

Because Magdo and Yamauchi, individually and in combination, fail to show or suggest every element of the claims, the Office action has failed to make a *prima facie* case of obviousness and the rejection is improper. Accordingly, Applicants respectfully request the rejection be withdrawn.

Section 103 - Claims 20 and 24

Applicants respectfully request reconsideration of the rejection of claims 20 and 24 under 35 U.S.C. § 103(a) as being unpatentable over Magdo in view of Yamauchi and further in view of U.S. Patent No. 4,379,726 (Kamamaru). Claims 20 and 24 are allowable for the same reasons discussed above with respect to claim 1.

In addition, claim 20 further recites a first epitaxial thickness between the first base layer and the first embedded diffusion layer and a second epitaxial thickness between the second base layer and the second embedded diffusion layer, the first

epitaxial thickness is less than the second epitaxial thickness, and only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

Kumamaru discloses a semiconductor device having n-type emitters 19, 23 disposed proximate p-type bases 17, 22 above a first n-type epitaxial layer 11 and a p-type epitaxial layer 5. The references do not show or suggest a first epitaxial thickness between the first base layer and the first embedded diffusion layer and a second epitaxial thickness between the second base layer and the second embedded diffusion layer, the first epitaxial thickness is less than the second epitaxial thickness, and only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer. As an initial matter, one of the epitaxial layers 5 below the emitters 19, 23 is a p-type epitaxial layer and the claimed epitaxial layer is an N-type epitaxial layer. Further, the Kamamaru device is quite different from the claimed device. For example, the Kamamaru device includes at least three epitaxial layers 11, 5, and 5a. The Office action asserts that Kamamaru discloses a device wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer. However, between the base layer 19 and the buried layer 12 is epitaxial layer 11 *and* epitaxial layer 5a. Thus more than *only the* epitaxial layer is disposed between the base layer and the second diffusion layer.

Further regarding claim 20, the Office action asserts that Kamamaru discloses a first epitaxial thickness that is less than a second epitaxial thickness. However, because the second buried layer 12 is disposed below the surface of the epitaxial layer 11 and the first buried layer 14 is disposed partly above the surface of the epitaxial layer, it is clear from Kamamaru (e.g., in Fig. 10) that the epitaxial distance between the second emitter 19 and the first buried layer 12 – i.e., the distance between the second emitter 19 and the lowest point on the epitaxial layer 11 – is actually greater than the epitaxial distance between the first emitter 23 and the first buried layer 15.

In addition regarding claim 20, the first buried layer 14 of Kamamaru is not formed in an upper part of the substrate, as claimed. To move the buried layer 14 down to the substrate would make the distance between the emitter 23 and the buried layer 14 substantially equal to the distance between the emitter 19 and the buried layer 12, and thus still outside of the scope of claim 4. Also, if the subcollector 22 of Magdo were kept in formative contact with the substrate 10, then the epitaxial layers 5 and 5a could

not be reasonably combined into the Magdo invention. Further, there is no motivation in either reference to somehow add the structure of Kamamaru into the structure of Magdo. Still further, a modification to references cannot leave those references unsatisfactory for their intended purpose or change the principle operation of the references. Including additional epitaxial layers and/or separating the subcollector 22 from the substrate 10 of Magdo would render Magdo unsatisfactory for its intended purpose and change the principle operation of the device.

Claim 24 recites the second vertical type bipolar transistor including a base layer disposed between two graft base layers wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer. As discussed above regarding the improper rejection of claim 20, Kumamaru fails to disclose or suggest these elements. Namely, between the base layer 19 and the buried layer 12 of Kamamaru is epitaxial layer 11 and epitaxial layer 5a. Thus, there are more layers disposed between the base layer and the second diffusion layer than only epitaxial layer 11.

Because Magdo, Yamauchi, and Kumamaru, individually and in any combination, fail to show or suggest every element of the claims, the Office action has failed to make a *prima facie* case of obviousness and the rejection is improper. Accordingly, Applicants respectfully request the rejection be withdrawn.

Conclusion

If the Examiner believes that there is an issue that could be resolved by an interview, Applicant requests the Examiner contact the undersigned attorney at the telephone number listed below.

As it is believed that the application is in condition for allowance, Applicants respectfully request a favorable action and Notice of Allowance.

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Respectfully submitted,



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